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PATENT SPECIFICATION

647,293

Date of Application and filing Complete Specification: April 29, 1948. No. 11774/48.

Application made in Switzerland on May 12, 1947.

Complete Specification Published: Dec 13, 1950.

Index at Acceptance :—**Class 51(i), A1b1a.**

. keine Ringbrennkammer!
. Silo-Brennkammer
. Eingehängte (vertikal) Wandelemente (Schwerkraft) mittels Friction
& AZ

COMPLETE SPECIFICATION.

Cooled Metallic Combustion Chamber for the Production of Heating and Driving Gases.

We, AKTIENGESELLSCHAFT BROWN, BOVERI & CIE., of Baden, Switzerland, a Swiss Company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

Various kinds of metallic combustion chambers are known for the production of heating and driving gases at moderate temperature for gas turbines. These combustion chambers consist mainly of two coaxial cylindrical wall elements, the inner one of which contains the combustion space and is made of highly heat-resistant sheet metal, whilst the outer wall element forms the pressure-proof casing. Secondary air is passed through the annular gap between the cylindrical wall elements and this air cools the inside element and after mixing with the combustion gases reduces the temperature of these gases to such a degree that these can be used directly for driving for instance a gas turbine.

It is also known to insert a third wall element between the inner and outer elements, this third element being cooled on both sides with air so that the outside element is protected against heat radiation. In this case it is necessary that the cooling medium should pass along the cylindrical wall at high speed so that there is a large transmission of heat.

High gas velocities, however, require additional power which particularly in gas turbine plants is an undesirable feature because it reduces the overall efficiency. It has therefore been proposed to construct the inside wall element of the combustion chamber of conical interpenetrating rings which are so arranged that annular channels are left free between them and the cooling medium can pass into the inside of the combustion chamber. By means of this subdivision it is possible to keep the flow path of each channel short, so that the flow resistance which has to be overcome is small. With this arrangement the cooling of the walls of the inner element is, however, still inadequate so that the wall temperature attains a considerable value.

When examining the question of the further cooling of the hot combustion chamber wall by means of a cooling medium, it must be remembered that the amount of heat transmitted is a function of the three values ; coefficient of heat transmission, temperature difference and heat exchange surface. At least one of these values must be large so that the radiated heat can pass to the cooling medium. Large coefficients of heat transmission necessitate a high velocity for the cooling medium, that is a large power consumption. The temperature difference cannot be increased because otherwise the life of the combustion chamber casing becomes too short. The third possibility, namely increasing the heat exchange surfaces on the cooling side, is at the basis of the present invention.

The present invention consists in a cooled metallic combustion chamber for producing heating and driving gases, with a pressure-proof outer casing and an internal wall element, the inside surface of which is in contact with the flame and the outside surface of which is cooled with a gaseous cooling medium, and of which the area of the cooled outside surface is several times greater than that of its inside heated surface, characterised by the feature that the internal wall element is provided with a plurality of interchangeable ribbed bodies which are suspended from the wall element in such a manner that they can expand freely in all directions.

The invention also consists in cooled metallic combustion chambers in accordance with any of Claims 2 to 13 inclusive.

By employing greatly increased surfaces for transmitting the heat from the internal wall element of the combustion chamber to the cooling medium, it is possible to work with low flow velocities which do not require

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additional power but still ensure a powerful cooling effect. Furthermore, by this means the pressure drop is kept small due to the cooling medium being divided up into a number of parallel streams each of which cools a short part of the combustion chamber wall and then flows into the inside of the combustion chamber where it mixes with the hot combustion gases. When these various measures are adopted, the pressure drop of the combustion air in the swirling nozzle is adequate to transport also the cooling air along the ribbed bodies.

Figures 1 to 7 of the accompanying drawings show various constructional examples of a combustion chamber and ribbed bodies in accordance with the invention.

Figure 1 shows a combustion chamber for producing the driving gas for a gas turbine. Air is supplied at 1 from a blower not shown in the drawing and divides into two streams in the top part 2 of the combustion chamber. Part of the air passes as combustion air through the swirling nozzle 3 into the actual combustion space 4 where fuel is injected through nozzle 5 into the turbulent combustion air. The remaining and larger part of the air is cooling air which flows into the space 6 between the inner wall elements 7 and outer casing 8 respectively of the combustion chamber. The inner wall element is in accordance with the invention provided with a number of ribbed bodies 9 which can expand freely in all directions and are suspended from the inner wall element 7 of the combustion chamber, which serves as supporting structure, so that they can readily be interchanged.

A combustion chamber according to the invention and constructed as shown in Figure 1*a* can for instance also be employed for producing heating gas for a steam boiler or superheater. Combustion air is supplied at 1*a* from a blower and passes through the swirling nozzle 3 into the combustion space 4 where fuel is injected by way of the fuel nozzle 5. The other medium which is supplied to the combustion chamber is flue gas which enters at 1*b* into the space 6 between the inner and outer wall elements 7 and 8 respectively and on the one hand in accordance with the invention serves as a cooling medium for the ribbed bodies, and on the other hand in a manner known *per se* has to reduce the gas temperature to such an extent that the heating gases can be brought into direct contact with the heat exchange surfaces.

Each ribbed body 9, as shown in Figure 2, consists of a radiation plate 10 which is next to the combustion zone, and of numerous ribs 11 on its outer side, whereby the heat transmitting surface is very considerably enlarged. The lugs 12 fit into openings 13 in the combustion chamber wall element 7 and thus serve to fix the ribbed bodies.

The suspended ribbed bodies 9 form numerous channels between the radiation plate, 10, ribs 11, and the inner wall element 7 of the combustion chamber; the cold cooling air enters these channels at 14 and after being heated to a considerable temperature can leave again at 15, the cooling air during this process passing into the inside of the combustion chamber in such a manner that after having flown through the channel formed by one ribbed body, it flows along the radiation plate 10 of another body.

In order to enable the cooling air to enter and leave the channels of the ribbed bodies freely, it is expedient if these latter are arranged in ring cylinders of different diameter which are telescoped into each other and overlap. The inner wall element 7 of the combustion chamber, which carries these ribbed bodies, thus consists of several sheet metal cylinders graded in diameter and each suspended from for instance star-shaped holders 16 which are supported on the outer wall element 8 of the combustion chamber. The ribbed bodies can expand freely in the axial direction and there is also sufficient clearance for expansion in the radial direction.

For a prescribed combustion chamber diameter and an arrangement such as is shown in Figure 3, the volume of the combustion space will be somewhat greater. Here the individual parts of the inner wall element of the combustion chamber consist of conical overlapping sheet metal rings 17 which are mutually supported by means of lugs 18. The bottom ring rests for instance on a bracket 19 fixed to the outer wall element 8 of the combustion chamber. Due to the fact that the diameter of the rings 17 is different at the top and bottom, the ribbed bodies 20 suspended from these rings are not rectangular but trapezoidal. In this way the individual parts for all combustion chamber sections have the same dimensions and this facilitates the keeping of spare parts.

From the manufacturing point of view it may be desirable to avoid the conical and trapezoidal shaped parts. In this case the ribbed bodies 21 can be arranged as shown in Figure 4 and consist of a straight part 22 and an adjoining bent part 23, these parts forming annular inlets for the cooling air when assembled together. The ribbed bodies 21 are supported from the wall element by means of hooks 24 which are carried for instance by holders 25 and bolts 26 arranged in star shape.

Another modified form of the invention is shown in Figure 5. The inner cylindrical wall element 7 of the combustion chamber is in one piece. For a prescribed external diameter of the combustion chamber, for

this arrangement results in a maximum combustion space. The annular ribbed bodies 27 are arranged at different levels and annular slots 28 are left free between them for the passage of cooling air into the combustion space. The cooling air passes through the openings 29 between the ribs of the individual ribbed bodies and divides into two approximately equal streams which flow along the ribs in opposite directions, whereby the air extracts heat from the ribbed bodies and passes to the nearest slot 28.

The ribbed bodies themselves can be provided with a curved radiation plate 10, as shown in Figure 2, which is suited to the curvature of the inner casing of the combustion chamber. Figure 6 shows a construction of ribbed body with a completely flat radiation plate 29 and four fixing hooks 30. These ribbed bodies when assembled together form a polygon-shaped combustion chamber wall.

The longer the ribbed bodies are made in the direction of flow of the cooling air, the more will this air, which subsequently mixes with the combustion gases, be heated up. On the other hand the wall temperature of the ribbed body should be as low as possible. It is found, however, that the length of the ribbed bodies with a prescribed cooling air outlet temperature reaches an optimum value at which the surface temperature is a minimum, so that any further lengthening of the ribbed bodies beyond this value does not improve the cooling effect.

With long ribbed bodies it is expedient to divide the ribs at least at one place as shown in Figure 6 at point 31. Due to the large temperature gradient in a direction transverse to the ribs, very large differences in expansion occur; the hot radiation plate 29 expands considerably more than the colder rib edges 32, so that the entire ribbed body bends in the direction of the gas flow. If for instance the ribs are cut in two in the middle, this bending is reduced by considerably more than half.

Since the radiation length of a ribbed body is constant, the wall temperature of its radiation plate increases in the direction of flow of the cooling medium. It is now possible by suitably selecting the cross-sections of flow to divide the available flow energy and thus the coefficients of heat transmission in such a way that the maximum temperature drops and the wall temperature of the radiation plate remains constant in the direction of flow. The cross-section is preferably varied by varying for instance the height of the rib transversely to the direction of flow, that is by making the cross-section greater at the inlet and smaller at the outlet.

The ribbed bodies are expediently made of heat-resisting material, for instance chrome steel. The ribs are then for instance machined out of the solid material, or highly heat-resistant sheet metal can be bent directly into ribs, as indicated in Figure 7.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Cooled metallic combustion chamber for producing heating and driving gases, with a pressure-proof outer casing and an internal wall element, the inside surface of which is in contact with the flame and the outside surface of which is cooled with a gaseous cooling medium and of which the area of the cooled outside surface is several times greater than that of its inside heated surface, characterised by the feature that the internal wall element is provided with a plurality of interchangeable ribbed bodies which are suspended from the wall element in such a manner that they can expand freely in all directions.

2. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are fixed in cylindrical sheet metal rings with graded diameters.

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3. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are fixed in conical sheet metal rings of the same size.

4. Combustion chamber as in Claim 1, characterised by the feature that each ribbed body consists of a straight part and an adjoining bent part, the bodies being so fixed to rings that the side in contact with the flame forms a substantially straight cylindrical combustion space.

5. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are fixed in a straight sheet metal cylinder in such a manner that the cooling air enters through openings in the central plane of a ring consisting of ribbed bodies, parts of the cooling air stream flowing in opposite directions along the ribs into the combustion space.

6. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are suspended from at least one hook.

7. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are curved on one side and thus adapted to the curvature of the combination chamber.

8. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are flat.

9. Combustion chamber as in Claim 1, characterised by the feature that the ribs of the ribbed bodies are sub-divided at least once in the transverse direction.

10. Combustion chamber as in Claims 1 and 3, characterised by the feature that the ribbed bodies have a trapezoidal shape.

11. Combustion chamber as in Claim 1, characterised by the feature that the ribbed bodies are made of a heat-resistant material.

12. Combustion chamber as in Claims 1 and 11, characterised by the feature that the ribs of the ribbed bodies are made of folded sheet metal.

13. Cooled metallic combustion chambers in accordance with Claim 1 constructed substantially as herein described.

MARKS & CLERK.

Dated this 29th day of April, 1948.

Abingdon : Printed for His Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1950. Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies, price 2s. 0d. each (inland) 2s. 1d. (abroad) may be obtained.

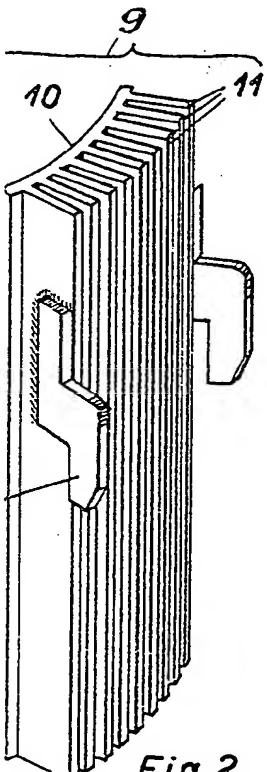


Fig.2

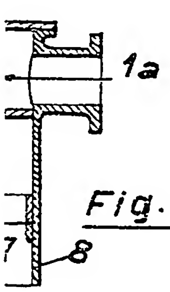


Fig.1a

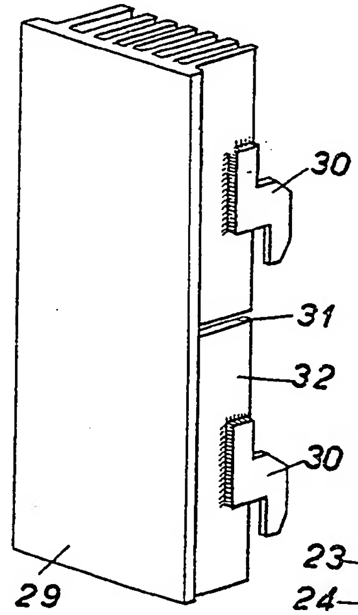


Fig.6

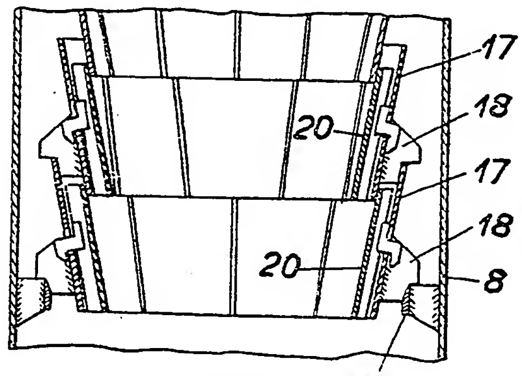


Fig.3

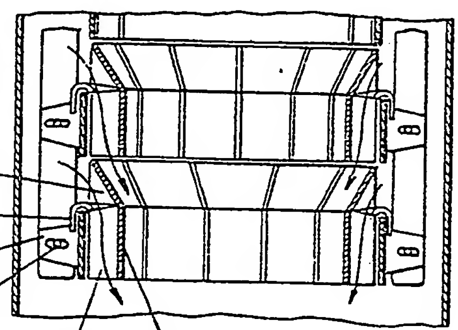


Fig.4

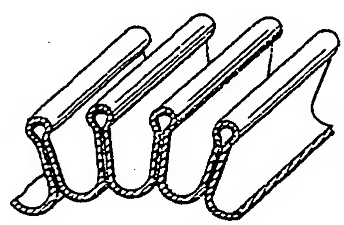


Fig.7

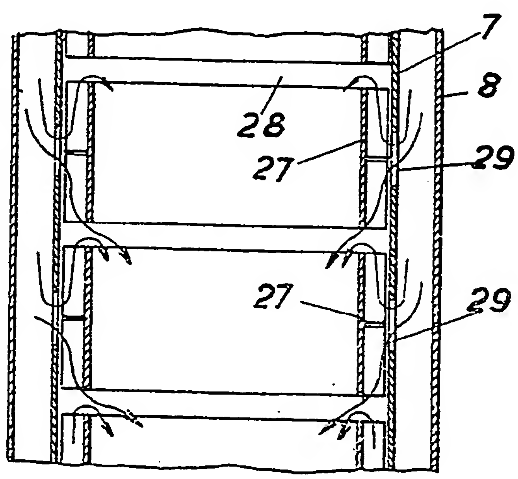


Fig.5

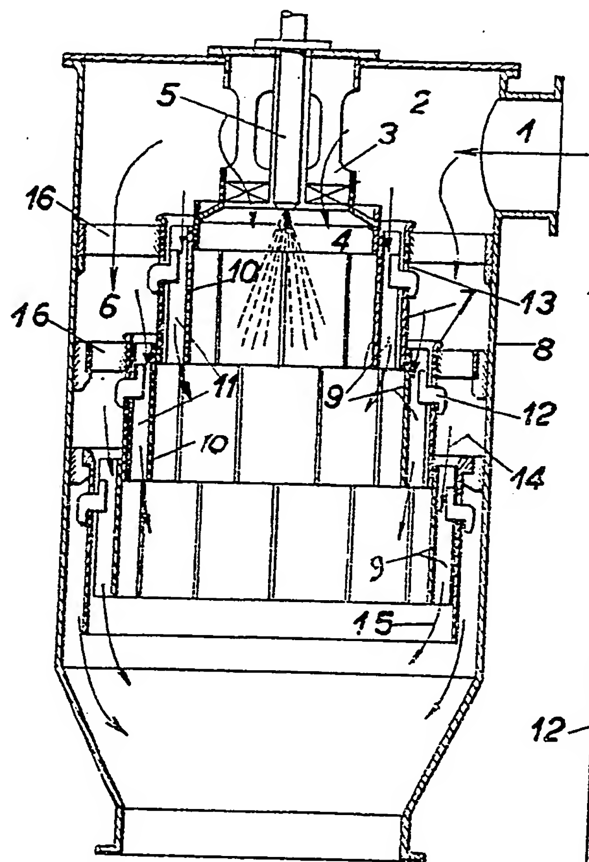


Fig.1

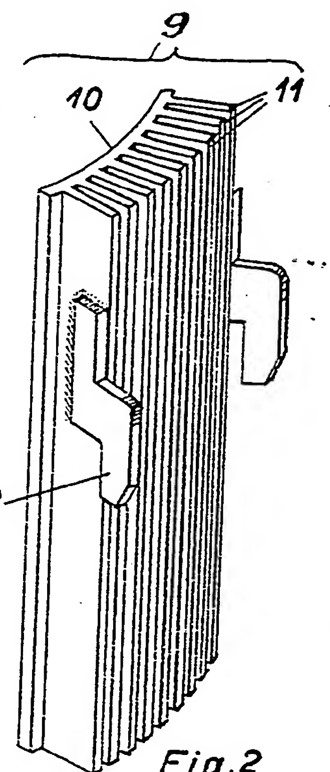


Fig.2

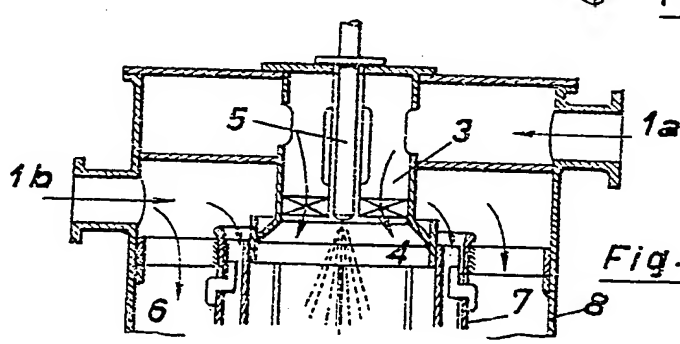
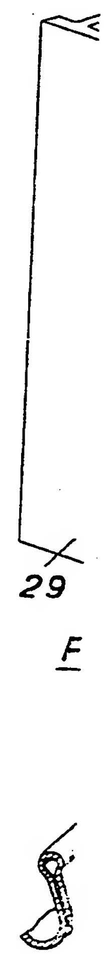


Fig.1a



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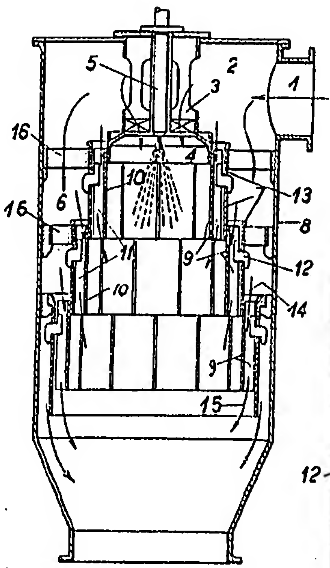

Fig.1

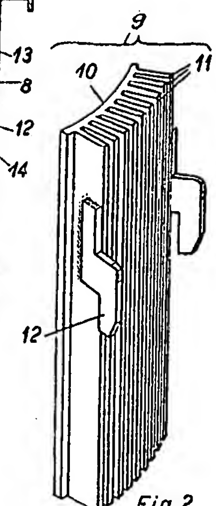

Fig.2

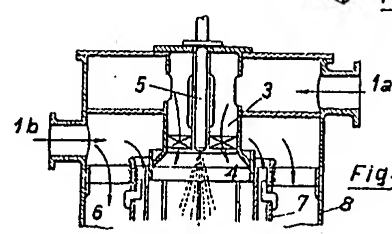

Fig.1a

[This Drawing is a reproduction of the Original on a reduced scale.]

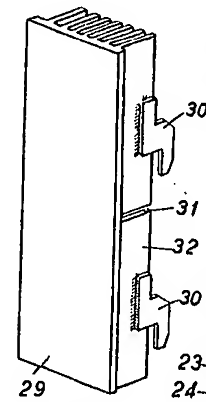

Fig.6

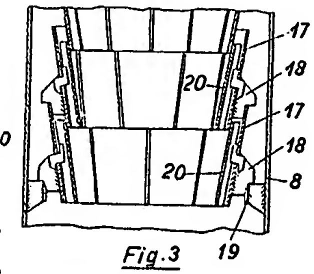

Fig.3

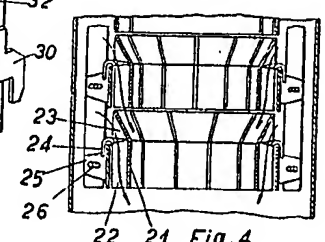

Fig.4

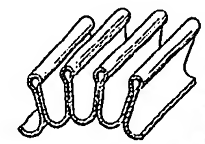

Fig.7

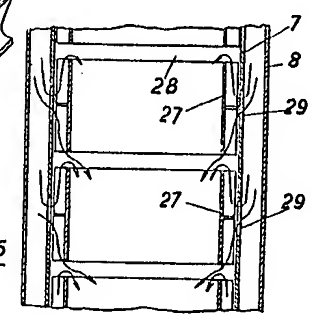

Fig.5